Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use in Mid-Band Spectrum	)	GN Docket No. 17-183
Between 3.7 and 24 GHz	)	

COMMENTS OF ERICSSON

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Ericsson submits these comments in response to the Commission's Notice of Inquiry ("*NOI*") on opportunities for wireless broadband services and other flexible uses in the bands between 3.7 and 24 GHz (the "mid-band spectrum"), particularly the 3.7-4.2 GHz, 5.925-6.425 GHz and 6.425-7.125 GHz bands.[1]

I. INTRODUCTION AND SUMMARY

Ericsson commends the Commission's inquiry into whether swaths of mid-band spectrum can be repurposed to enable wireless broadband services. The *NOI* is timely. Demand for wireless services is exploding: as the Ericsson Mobility Report observes, mobile data usage in North America is expected to increase five-fold between 2016 and 2022, with total mobile data usage reaching approximately 10 ExaBytes (EB) per month (the equivalent of five billion hours of movie watching).[2] And Internet of Things ("IoT") connections are projected to increase by more than 200 percent, reaching 213 million by 2022 and accounting for over 30 percent of

[1] *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, Notice of Inquiry, 32 FCC Rcd 6373 (2017) ("*NOI*").

[2] Ericsson Mobility Report (June 2017) at 33, https://www.ericsson.com/assets/local/mobilityreport/documents/2017/ericsson-mobility-report-june-2017-north-america.pdf.

all cellular connections.[3] Wireless innovation, next-generation technologies, and the emergence of 5G will drive demand for cutting edge services and applications – all of which means that technology alone will not fulfill the traffic demand and the need for more wireless broadband spectrum is acute.

Ericsson applauds the Commission's resolve to identify more flexible-use spectrum opportunities including in the mid-band. It is clear that a combination of spectrum across low-, mid-, and high-bands will optimize wireless broadband deployments.[4] Low-band spectrum is well suited for signal range and indoor penetration, while higher frequency bands, such as those in the millimeter waves, are well suited to support high capacity, but with a more limited range and with limited indoor penetration. Mid-band spectrum offers a balance of these capabilities, complementary to millimeter wave in urban and suburban settings and extending the availability of 5G beyond densely populated areas. But thus far, mid-band spectrum is a frequency range that has received little U.S. focus. Indeed, Chairman Pai recently observed: "As the world goes wireless, as consumers rely ever more heavily on their mobile devices, we need to keep up – and that means in part looking at spectrum bands 'in the middle,' where the FCC historically hasn't focused."[5]

Mid-band spectrum offers a critical opportunity to identify licensed spectrum with adequate bandwidth to enable a robust 5G ecosystem and support stand-alone deployment of new air interfaces like New Radio ("NR"). NR is a globally standardized radio access

[3] *Id.*

[4] *See e.g.*, Comments of Ericsson, GN Docket No. 14-177 et al. (Jan. 15, 2015).

[5] Statement of Chairman Ajit Pai re: *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, GN Docket No. 17-183, FCC 17-104 (rel. Aug. 3, 2017).

technology for 5G.[6] With NR, mobile network operators will be able to bring 5G to consumers using mid-band spectrum while boosting network capacity.[7]

The Commission rightly focuses near-term efforts on the 3.7-4.2 GHz, 5.925-6.425 GHz, and 6.425-7.125 GHz bands, as the amount of exclusive non-federal spectrum in the 6-24 GHz range is limited. Over the longer term, however, Ericsson urges the Commission and NTIA to explore opportunities for additional mobile allocations and more federal/non-federal shared bands especially in the 7-24 GHz band range. As discussed below, the Commission can establish a strong platform for wireless broadband in the subject bands by issuing a notice of proposed rulemaking as follows:

1) Pursue flexible-use licensed opportunities in the 3.7-4.2 GHz band using market-based mechanisms to clear that spectrum;

2) Explore the introduction of new licensed opportunities in the 6.425-7.125 GHz bands;

3) Pursue unlicensed opportunities in the 5.925-6.425 GHz with an emphasis on rules that render the band neutral to choice of technology;

4) Ensure that incumbent fixed service point-to-point operations in the 5.925-6.425 GHz and 6.425-7.125 GHz bands are protected from harmful interference;

5) Examine whether to transition the 7.125-8.5 GHz band from an exclusive federal band to a shared one; and

6) Adopt changes to existing long-haul backhaul rules to better support, next-generation, high-throughput services.

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[6] Zaidi, *Three Design Principles of 5G New Radio*, Ericsson Research Blog (Aug. 7, 2017), https://www.ericsson.com/research-blog/three-design-principles-5g-new-radio/. Ericsson recently introduced a new radio product, AIR 3246, that supports both 4G/LTE and 5G New Radio technologies and is Ericsson's first 5G NR radio for frequency division duplex (FDD).

[7] *Ericsson introduces new radio product for Massive MIMO*, ETTelecom (Sept. 5, 2017), http://telecom.economictimes.indiatimes.com/news/ericsson-introduces-new-radio-product-for-massive-mimo/60378378.

With the proper regulatory framework, the 3.7-4.2 GHz, 5.925-6.425 GHz and 6.425-7.125 GHz bands can provide additional spectrum for 5G and achieve the Commission's objectives in this proceeding.

II. THERE IS GROWING GLOBAL INTEREST IN THE USE OF THE MID-BAND SPECTRUM FOR 5G, AND CONTINUED U.S. LEADERSHIP CALLS FOR A MEANINGFUL U.S. MID-BAND INITIATIVE

The *Notice of Inquiry* references the growing "international interest in identifying new frequency bands for wireless broadband below the 24 GHz frequency range."[8] Indeed, other countries have seized on mid-band spectrum as an increasingly important part of the spectrum mix for 5G: "From China and Japan to Australia and the United Kingdom, countries around the world have identified mid-band spectrum as a key set of frequencies to deliver next-generation 5G wireless services and unlock the full potential of the Internet of Things. These countries are moving aggressively, already auctioning or allocating swaths of mid-band airwaves so their wireless industries can develop the mobile devices, chipsets, and infrastructure that put this spectrum to use."[9] By way of example, Australia, China, the European Union, Ireland, Japan, Russia, South Korea, and the United Kingdom have all recently taken steps to make 3 GHz spectrum available for 5G.[10]

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[8] *NOI* ¶ 4.

[9] Meredith Attwell Baker, *Op-Ed: The FCC's Mid-Band Spectrum Vote is Key for America's 5G Leadership*, Wireless Week (July 31, 2017), https://www.wirelessweek.com/article/2017/07/op-ed-fccs-mid-band-spectrum-vote-key-americas-5g-leadership.

[10] *See* Australian Communications and Media Authority, *Australia's Approach to the 3.6 GHz Band* (June 23, 2017), http://www.acma.gov.au/theACMA/australias-approach-to-the-36-ghz-band; Monica Alleven, *China Issues Plan to Use 3300-3600 MHz, 4800-5000 MHz for 5G*, FierceWireless (June 7, 2017), http://www.fiercewireless.com/wireless/china-issues-plan-to-use-3300-3600-mhz-4800-5000-mhz-for-5g; European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions, *5G for Europe: An Action Plan*, at 5 (Sept. 14, 2016); Commission for Communications Regulation, *Results of the 3.6 GHz Band Spectrum*

As a key element of U.S. spectrum policy, the U.S. Government should endeavor to be party to any global spectrum harmonization effort – including in the mid-band. Spectrum harmonization translates directly into readily accessible, more affordable equipment and quicker deployment. 3GPP has already defined a number of bandplans. The 3.7-4.2 GHz frequency range has been recently integrated in 3GPP as a new band, Band 77 (3300-4200 MHz), and two other 3GPP bands partially cover this range, Band 43 (3600-3800 MHz) and Band 79 (3300-3800 MHz). With all this activity, a strong mid-band spectrum platform for wireless broadband is imperative for U.S. leadership on 5G and to spur a new wave of innovation.

This *NOI* is a critical step towards continued U.S. leadership in wireless. Ericsson urges the Commission to promptly review the record and launch a notice of proposed rulemaking to effectuate the goals identified here.

III. 3.7-4.2 GHz BAND HOLDS GREAT PROMISE FOR LICENSED, FLEXIBLE-USE SERVICE

A. The 3.7-4.2 GHz Band Should be Repurposed for Licensed, Mobile Broadband Use

The 3.7-4.2 GHz band is a prime candidate for mobile deployment and the Commission should explore all opportunities to designate the band for flexible use. As noted, other leading

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Award, ComReg 17/38 (May 22, 2017), https://www.comreg.ie/media/dlm_uploads/2017/05/ComReg-1738.pdf; GSMA, *Forward Thinking for Spectrum: Getting Ready for 5G*, GSMA-GSA Seminar, ITU World Telecom (Nov. 16, 2016), https://www.gsma.com/spectrum/wp-content/uploads/2016/11/GSMA-GSA-5G-seminar-panel-session.pdf; GSMA & China Academy of Information and Communications Technology, *5G in China: Outlook and Regional Comparisons* (July 2017),https://www.gsmaintelligence.com/research/?file=67a750f6114580b86045a6a0f9587ea0&download; Jin-young, *South Korean Government to Secure 40 GHz Frequency Width for 10 Years*, BusinessKorea (Dec. 23, 2016), http://www.businesskorea.co.kr/english/news/ict/16837-strategic-securement-southkorean-government-secure-40-ghz-frequency-width-10-years.

nations are committing the 3 GHz band to 5G,[11] and vendor investments and innovations are well underway. And here in the United States, the 3.55-3.7 GHz band is soon to open for the new CBRS service and mobile broadband deployment is immediately adjacent, creating further synergies for flexible-use spectrum. If the U.S. is to maintain wireless leadership, it should open the band for flexible use.[12] As the Commission has previously stated:

> [F]lexibility will promote broadband deployment, ensure the spectrum is put to its most beneficial use, and maximize the probability of success for new services. . . [W]e expect that flexibility will allow any licensee . . . '[to] maximize the value of the spectrum resource both to the licensee and the public.'[13]

The Commission should pursue exclusive-use, flexible rights licensing in the 3.7-4.2 GHz band. A licensed regime will create a robust ecosystem in the band and will promote investment and innovation (such as deployment of new interfaces like NR) and encourages rapid deployment of 5G facilities. This means predictable channel allocations that operators may rely on for availability and performance. Database approaches for managing access to licensed spectrum are not advisable. These methods are still in development, have not yet been widely

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[11] GSA White Paper, *The future of IMT in the 3300 - 4200 MHz Frequency Range* (2017), https://gsacom.com/paper/future-imt-3300-4200-mhz-frequency-range/.

[12] As noted in the *NOI*, in a separate proceeding the Broadband Access Coalition has filed a petition for rulemaking asking the Commission to authorize the deployment of licensed point-to-multipoint fixed wireless broadband service in the 3.7-4.2 GHz band. *NOI* ¶ 17. *See also Consumer & Governmental Affairs Bureau Reference Information Center – Petition for Rulemakings Filed*, RM-11791, Report No. 3080 (rel. July 7, 2017); Broadband Access Coalition Petition for Rulemaking, RM-11791 (filed June 21, 2017). Continued consideration of the BAC petition in a separate proceeding would not serve the public interest. Rather, the petition should be considered solely in the context of the *NOI*, so that the Commission may ensure that the petition does not limit its ability to permit mobile use in the 3.7-4.2 GHz band.

[13] *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102, 16187 ¶ 224 (2012) (footnotes omitted).

deployed, and do not yet provide a proven spectrum environment that carriers require for network planning.

B. There are Multiple Options for Repurposing the 3.7-4.2 GHz Band Without Compromising Incumbent Services

On the heels of the Broadcast Incentive Auction, the 3.7-4.2 GHz band presents another opportunity for the Commission to apply market-based mechanisms to clear incumbents from spectrum as much as possible and repack those who remain to enable the introduction of new wireless broadband services including 5G. Ericsson believes this is the most expeditious way to gain access to the 3.7-4.2 GHz band in a timely manner. There are a variety of options for clearing the band, and the Commission should consider all of them.

Options include an incentive auction or other market-based model in which incumbents agree to surrender spectrum rights for payment from new entrants. Incumbent Fixed Satellite Service ("FSS") C-band satellite operators and receive station licensees could choose to relocate to other spectrum (e.g., the Ku-band), transition traffic to another transmission platform (e.g., fiber or fixed service), or move downlink operations to more remote areas subject to interference protection from new entrants (with fiber or other technologies for backhaul). As the Commission notes, current incumbent Fixed Service ("FS") use of the 3.7-4.2 GHz band is "relatively minimal (119 licenses),"[14] and point-to-point microwave incumbents in the band could move to other spectrum, perhaps including the 7.125-8.5 GHz band if the FCC and NTIA were to consider enabling shared use of this FS band.

In addition, the Commission could make more spectrum available at 3.7-4.2 GHz by improving spectrum efficiency and by limiting or prohibiting future satellite deployments in the band. As the Fixed Wireless Communications Coalition ("FWCC") noted, the Commission

[14] *NOI* ¶ 15 (footnote omitted).

should reexamine the "full band, full arc" frequency coordination procedures for FSS receive earth stations where every earth station is permitted to coordinate across an entire frequency band and over the entire geostationary arc, regardless of how little spectrum the earth station plans to use and how few satellites it plans to access.[15] This leaves valuable spectrum in the 3.7-4.2 GHz band idle, even where it could be used for other services.

Ericsson is less optimistic that wireless broadband systems, C-band earth stations, and fixed microwave facilities will be able to share the 3.7-4.2 GHz band on a co-channel basis. Attachment A to these comments outlines Ericsson's findings, which indicate the need for at least 30 kilometers, under favorable conditions, of separation between a terrestrial wireless base station and a C-band earth station in order for the two services to co-exist on the same spectrum.[16]

Lastly, Ericsson recognizes that clearing the 3.7-4.2 GHz band may take time and that band segmentation could be a feasible interim measure. Ericsson's initial studies indicate that adjacent channel co-existence between terrestrial base stations and C-band receive stations is possible with far smaller separation distances of between 2 to 5 kilometers. This may still require other market based solutions depending on the particular nature and location of the earth station and terrestrial wireless basestation. Band segmentation could help achieve a market-oriented solution that involves some incumbents vacating and some repacking into a smaller

[15] Fixed Wireless Communications Coalition, Inc. Petition for Rulemaking, RM-11778 (filed Oct. 11, 2016). FWCC has asked the Commission to amend its rules so that, subject to certain exceptions, conditions on FSS frequency coordination more closely parallel those for co-primary fixed services ("FS"). *Id*. at 8.

[16] The analysis assumes a terrestrial wireless base station operating consistent with Recommendation ITU-R F.1336 and 3GPP TS 36.104 v.14.4.0, and a satellite earth station that operates with parameters consistent with Recommendations ITU-R S.465 and ITU-R S.2368-0. *See* Attachment A.

portion of the 3.7-4.2 GHz band, along with rule changes to improve spectrum efficiency within the band.

IV. THE COMMISSION SHOULD PURSUE BOTH LICENSED AND UNLICENSED OPPORTUNITIES IN THE 6 GHZ BAND

A. If the Introduction of Unlicensed Operations in the 5.925-6.425 GHz Band Can Protect Point-to-Point Operations in the Band, Ericsson Supports Unlicensed in the Band

The Commission requests comment on whether it should allow unlicensed use in the 5.925-6.425 GHz band, noting that spectrum's proximity to the U-NII spectrum in the 5 GHz band.[17] As the Commission is well aware, the 5.925-6.425 GHz spectrum is a priority band for long-distance backhaul and is heavily used (over 27,000 FS licenses).[18] Given the existing uses today, including public safety and utility links, and the projected increases in backhaul driven by the explosion in mobile data traffic and high-capacity 5G services outlined above, it is essential that the Commission provide sufficient resources for backhaul, including use of the 5.925-6.425 GHz band. Thus, while Ericsson supports the introduction of unlicensed services, on a technology neutral basis, into the 5.925-6.425 GHz band, the Commission must ensure that those services do not cause harmful interference to FS incumbents and that FS can continue to deploy additional links in the band.

B. The Commission Should Expand Licensed Wireless Service in the 6.425-7.125 GHz Band and Work With NTIA to Explore Non-Federal Use of the 7.125-8.5 GHz Band

The Commission should explore the introduction of licensed mobile service in the 6.425-7.125 GHz band, while also ensuring that opportunities continue to exist for long-haul point-to-point links where needed, especially in rural areas. To that end, the Commission should also

[17] *NOI* ¶ 26.

[18] *Id*. ¶ 25.

work with NTIA to open the 7.125-8.5 GHz band for non-federal point-to-point links that can share with Federal FS operations in the band. The Commission should again look to market-based solutions as a way to accommodate these varying interests.

There are at present limited opportunities for non-federal mobile allocations between 7-24 GHz, and so the Commission should take a close look at the 6.425-7.125 GHz band for mobile service. The 6.425 to 7.125 MHz band could serve as a great complement to the millimeter wave band for use cases in urban core and densely populated areas, and beyond. As but one example, the band could be particularly useful for the deployment of next-generation applications such as automotive/connected car.

Any such initiative, however, must account for FS service currently in the band. The amount of backhaul spectrum in the United States already lags behind that in other parts of the world, particularly below the 10 GHz band. In fact, many countries have twice as much backhaul spectrum as the United States in the 5.925-8.5 GHz range.

Here again, the Commission should consider market-based remedies to transition incumbent operations out of the band, either to another band or to fiber, with a particular focus transitioning uses in more urban and suburban areas. For instance an overlay auction could be conducted where winning bidders compensate fixed incumbents to move out of the band; use of mid/short range microwave in higher frequencies or fiber are obvious alternatives. The sparse point-to-point long range deployment should not block other valuable usages, such as 5G, in urban/suburban areas. The remaining links located in rural areas can either be transitioned in part or whole over time.

Ericsson urges the Commission and NTIA together to examine whether to transition the 7.125-8.5 GHz band from an exclusive federal band to a shared one. Such action, proposed in

2010 by the Fixed Wireless Communications Coalition,[19] would enable relocation of non-federal FS incumbents to adjacent frequencies with identical propagation characteristics and would open up a significant new band for mobile services. Access to the 7.125-8.5 GHz band, moreover, would enable the truly high-capacity long haul point-to-point links of the future. There will soon be a need for more spectrum to support backhaul requirements with multi-gigabit capacity needs. As an example, one 10 Gbps point-to-point long range link requires 2x560 MHz of aggregated channel bandwidth. So to provide up to 10 Gbps long range links (in rural and remote areas) 1120 MHz is needed. Along with the lower and upper 6 GHz band, access to the 7.125-8.5 GHz band would have profound benefit for backhaul, especially in more remote areas where wireless links are the only realistic option for long-haul links.

Alternatively, if such an approach cannot be achieved, the Commission should adopt changes to existing rules governing the band to better support 5G backhaul, i.e., enabling wider bandwidth channelization to carry next-generation, high-throughput services.

V. CONCLUSION

Ericsson urges the Commission to review the record in this proceeding promptly and launch a notice of proposed rulemaking that makes the proposals identified above.

[19] Fixed Wireless Communications Coalition, Inc., Petition for Rulemaking, Amendment of Parts 2 and 101 of the Commission's Rules to Provide for Federal and Non-Federal Sharing in the 7125-8500 MHz Band, RM-11605 (Mar. 16, 2010).

Respectfully submitted,

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Attachment A

Co-channel Sharing Assessment

Ericsson has performed an analysis of coexistence between IMT-Advanced Macro-cell Base Stations and FSS space-to-earth receivers in the 3.7-4.2 GHz band. Ericsson focused primarily on the Interference from in-band IMT-Advance emissions and Interference from adjacent band IMT-Advance emissions. The conclusions of the study are also applicable to the consideration of 5G air interfaces such as NR when used with fixed or adaptive beamforming and applied to a similar interference situation

Based on parameters provided for satellite receivers covered in Recommendations ITU-R S.465 and ITU-R S.2368-0 and parameters provided for IMT transmitters covered in Recommendation ITU-R F.1336 and 3GPP TS 36.104 v.14.4.0, Ericsson's analysis shows that the interference from IMT-Advanced BS towards satellite systems is expected to be significantly higher than the interference thresholds (i.e. Interference-to-noise ratio) at the satellite receiver. The analysis concludes co-channel sharing between IMT and FSS earth stations in this band leads to significantly large separation distances, i.e. >30Km in the best case scenario examined, where the FSS earth station operates with 40 degrees elevation angle and an interference threshold of I/N=-3dB Such large required separation distances diminish sharing possibilities in the populated areas.

FSS Earth stations operate in a variety of environments with urban settings accounting for approximately 47% of the total earth stations deployed in the US markets and suburban settings accounting for 18%. Terrestrial mobile systems are expected to be deployed in proximity to FSS earth stations in the 3.7-4.2 GHz band. Therefore, the analysis considered both Urban and Suburban scenarios as these scenarios represent approximately 65% of the FSS deployment scenarios.

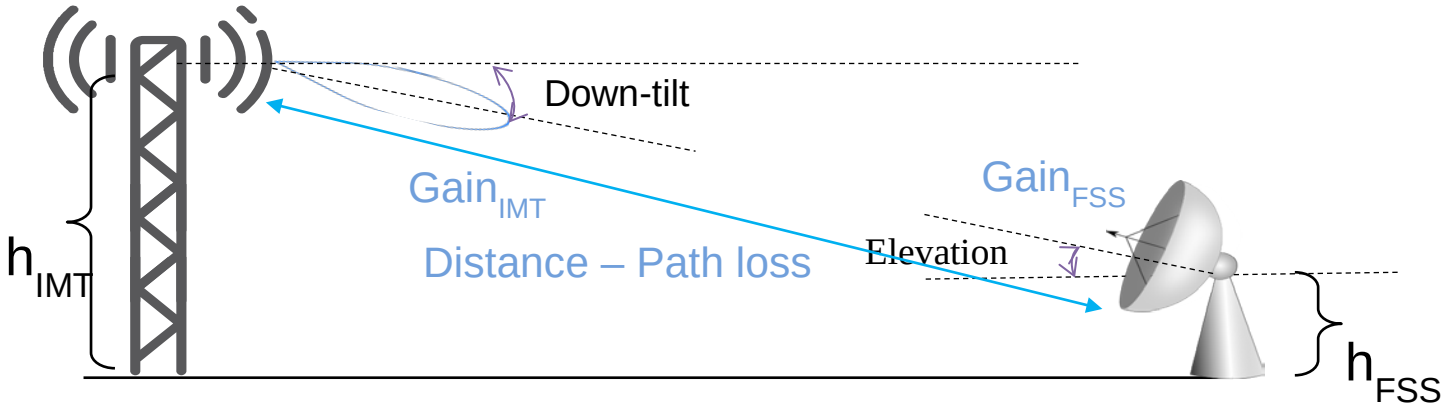

Figure 1. Sharing Scenario

Satellite System Aspects

As shown in Figure 1, the satellite-to-earth link (*i.e.*, downlink) is modeled by an earth station receiving towards the satellite with a dish antenna with a certain diameter and elevation angle according to the FSS deployment scenario. FSS antennas in this band may be deployed in a variety of environments. For urban deployments, smaller dish antennas with high elevation angle are commonly deployed on the rooftops; whereas for suburban or rural, larger dish antennas with low elevation angle are typically mounted on the ground. Ericsson's analysis looked at elevation angles between 5 and 40 degrees and dish antennas with diameters of 2.4 and 9 meters. The antenna reference pattern is based on Recommendation ITU-R S.465.

FSS Receiver		
Earth station deployment	Suburban	Urban
Channel Bandwidth (MHz)	36	36
Antenna Gain (dBi)	49.9	38
Antenna diameters (m)	9	2.4
Receiver system noise temperature (K)	70	100
Above ground level (m)	10	30

Table 1. FSS Characteristics

Terrestrial Mobile Aspects

The IMT system is modeled utilizing a base station transmitting in the direction of the earth station. Ericsson analysis considered antenna downtilt of 6 and 10 degrees for the macro suburban and macro urban scenarios, respectively. The filter characteristics are described in 3GPP TS 36.104 v.14.4.0 6.6. The antenna reference pattern followed Recommandation ITU-R F.1336 (3.1.1) for sector antennas. The maximum antenna gain is 18dBi.

IMT Transmitter		
Base station deployment	Macro suburban	Macro Urban
Antenna height (m)	25	20
Antenna pattern	Recommendation ITU-R F.1336 (recommends 3.1) Ka =0.7, Kp=0.7, kh=0.7 , kv=0.3 Horizontal 3 dB beamwidth: 65 degrees Vertical 3 dB beamwidth: determined from the horizontal	

	beamwidth by equations in Recommendation ITU-R F.1336.
Feeder loss (dB)	3
Maximum base station output power	46 dBm/10MHz

Table 2.IMT Characteristics

Analysis Results

The propagation model is based on ITU-R P.452-16.[20] Terrain profile was included and clutter losses at the transmitter and receiver side were also considered. For the analysis, the Interference criterion compared separation distances assuming *I*/*N* = –3,-6, -9, -12 dB. Apportionment of interference into an FSS link is half of the total noise interference. The conclusions:

- Co-channel sharing between IMT Macro and FSS earth receivers leads to separation distances as high as 50-70 km for I/N values below -6 dB and FSS elevation angle of 5 degrees.
- Considering that 65% of FSS receivers are located in urban/suburban locations, such large separation distances will eliminate possibilities for co-channel sharing in the populated areas.

[20] Propagation executed in area mode with the percentage of time for which the particular values of basic transmission loss are not exceeded equal to 50%.